U!REKA
EUROPEAN UNIVERSITY

Research and Innovation Agenda U!REKA Centre of Expertise Climate Neutral and Resilient Cities

Draft 1 July 2025

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1. Introduction to U!REKA Centres of Expertise

Objectives and contributions of U!REKA research and innovation

Supporting the EU Missions and other European initiatives. The European missions put research and innovation into a new role, combined with new forms of governance, participation and collaboration, in which engaging citizens, academics, students and professionals is key. EU Missions are a coordinated effort by the Commission to pool the necessary resources in terms of policies and regulations, as well as other activities [1] U!REKA will support the EU Mission: ”Climate Neutral and Smart Cities” [2] with close links to the EU Mission on Adaptation to Climate Change” [3], a Soil Deal for Europe” [4], and the proposed new Facility on New European Bauhaus [5].

Applied research and innovation (R&I) within the U!REKA European University will serve three purposes:

1. To contribute to the European state-of-the-art on evidence-based solutions towards our mission of climate neutral and smart cities
2. To respond to the specific challenges needs for our local, regional international stakeholder communities for research support on their strategies, policies, investments, decisions and activities towards climate neutral and smart cities
3. To provide the joint challenge-based learning and education to be developed within U!REKA with the necessary knowledge and research context, and to allow students to participate in research as an educational setting

These R&I activities will be clustered in three complementary and strongly linked U!REKA Centres of Expertise: Climate Neutral and Resilient Cities, Transition to Circular Society, and Innovative Governance and Citizen Engagement.

This document addresses the overall R&I focus of the three U!REKA CoEs collectively. It should be noted that the R&I strategy will be continuously updated in line with the challenges our societal partners identify, European state-of-the-art and the further development of U!REKA’s maturing as a European University.

U!REKA research focus

We can distinguish between 1) the initial focus that serves as the starting point of the U!REKA CoEs, and 2) the continuous cycle with which our R&I portfolio is finetuned towards the emerging needs of our stakeholder communities and educational programmes. The focus and selection of specific R&I areas is based on a combination of top-down (mission-led) and bottom-up (expertise-driven) approaches:

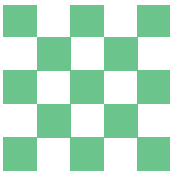
- The EU R&I agenda and the specific role of UAS in the European R&I landscape.

- Urban challenges that R&I will address. The engagement and interaction with U!REKA associated partner cities and regions, facilitated through the through cross-border events of the knowledge-creating community, to share experiences and know-how from across different ecosystems and stakeholders on the needs of our cities and urban stakeholders and the urban challenges they have identified.
- The ideas and suggestions of the U!REKA research community, which is based on the current research expertise at the U!REKA partners and the potential for strengthening through collaboration toward the urban challenges (bottom-up, driven by research staff expertise).
- Value for challenged-based education.
- Opportunities for financing of U!REKA research projects, such as the work programmes of Horizon Europe.
- EU policies on smart and climate neutral cities.

During the year 2024, the first year of the U!REKA project, we have identified an initial list of research areas. This was based the input from U!REKA partner universities' academic staff and research managers. The initial set of data was collected from online meetings and workshops of the three U!REKA Centres of Expertise, where researchers were asked about their areas of expertise and interests. Metropolia UAS also conducted a workshop for their research management to define institutional priorities on the research areas. We will match the research areas with the R&I needs that arise from the challenges European cities face in their pathways towards climate neutrality and resilience in a joint knowledge-creating community meeting.

Our R&I priorities are not static. The research agenda is updated annually and prioritised based on the input of the U!REKA knowledge-creating community, which integrates across borders all the local stakeholder communities of the participating HEIs, their associated regions and cities. The aim is to align the joint agenda towards solving challenges that the U!REKA partner cities face, and which can be solved by pooling and combining the expertise from different U!REKA stakeholders, even those who are based in a different location. In addition, we take into account 1) the EU R&I agenda 2) the new suggestions and initiatives of U!REKA researcher community, 3) any changes in the partners' research portfolio, as well as 4) the challenges communicated from our associated partners.

In the coming period, U!REKA's knowledge creating community will further develop, which will identify specific needs for applied research. These will be incorporated into the portfolio of the CoEs. Also, U!REKA research activities will provide the expert knowledge that is required for challenged based learning in U!REKA. This research and innovation agenda therefore, is very much subject to an open and dynamic process, to be updated regularly.



2. R&I agenda U!REKA CoE *Climate Neutral and Resilient Cities*

Since the start of U!REKA, we have learnt that city's resilience to climate change (adaptation) is increasing in urgence, for our cities as well as in the EU's research and innovation agenda. It is not enough to focus on climate neutrality only. We have therefore broadened the scope of this CoE to include research and innovation of climate change resilience and revised the name of the CoEs to reflect this. Research on climate-neutral and climate-resilient cities focuses on the costs, benefits and implementation of policies and practical measures that can implement in urban areas to reduce greenhouse gas emissions and adapt to the adverse effects to climate change. Note that some research focus is not only relevant for climate neutral and resilient cities but also contribute to the other CoEs [6].

2. 1. Research focus 1: Smart and energy efficient buildings

Buildings are a significant contributor to global energy consumption and greenhouse gas (GHG) emissions, especially in urban areas. Smart and energy-efficient buildings play a critical role in mitigating climate change by reducing energy use, lowering carbon footprints, and improving the performance of urban energy infrastructures. Smart building systems can also contribute to other functionalities and requirements of buildings

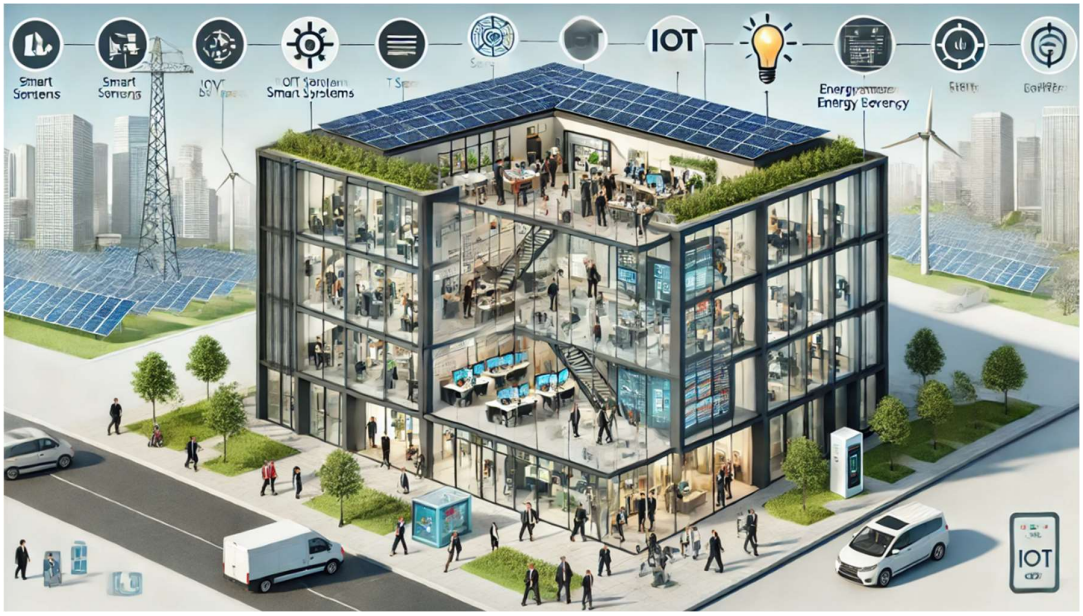
Implementing energy-efficient technologies and practices in buildings reduces the overall energy demand. This includes better insulation, energy-efficient lighting, and smart thermostats. In U!REKA, specific areas are the refurbishment and renovation of existing buildings, in particular heritage buildings. For renewable energy, the area includes incorporating renewable energy sources like solar, wind, and geothermal into building designs. Effective energy management in buildings can significantly reduce GHG emissions by optimising energy use and integrating renewable energy sources, as well increase the functionalities of the building and the well-being of its inhabitants.

Within this research focus, the following topics are addressed:

- Smart buildings: Convergence of AI and IoT technologies for optimising building performance.
- Building information modelling (BIM): Enabling and promoting a comprehensive adoption of BIM in all stages of construction life cycle through. Fast creation of BIM models through automation of scan-to-BIM processes. Knowledge graphs as flexible representations of BIM to support the integration of AI technologies.
- Digital twins of built environment: Development of digital models mirroring the structures, conditions, events, and processes in built environment.
- Linked building data: Enrichment of BIM models through linking of information about products and materials, LCA, sustainability, and reusability of building components

- Digital accessibility: Natural and effortless digital solutions for elderly or disabled people to support independent and enjoyable living
- Advanced energy management systems: Use of data and automation to optimise energy use in real-time.
- Pilots in own university campus of U!REKA partners
- New smart IoT sensors and actuators
- Local energy generation and energy storage
- Indoor localisation solutions

A joint research project on smart buildings, financed by the Dutch government, has started with several U!REKA partners. This project will secure the research cooperation on smart buildings within U!REKA for the coming period.



Smart building. Source ChatGPT

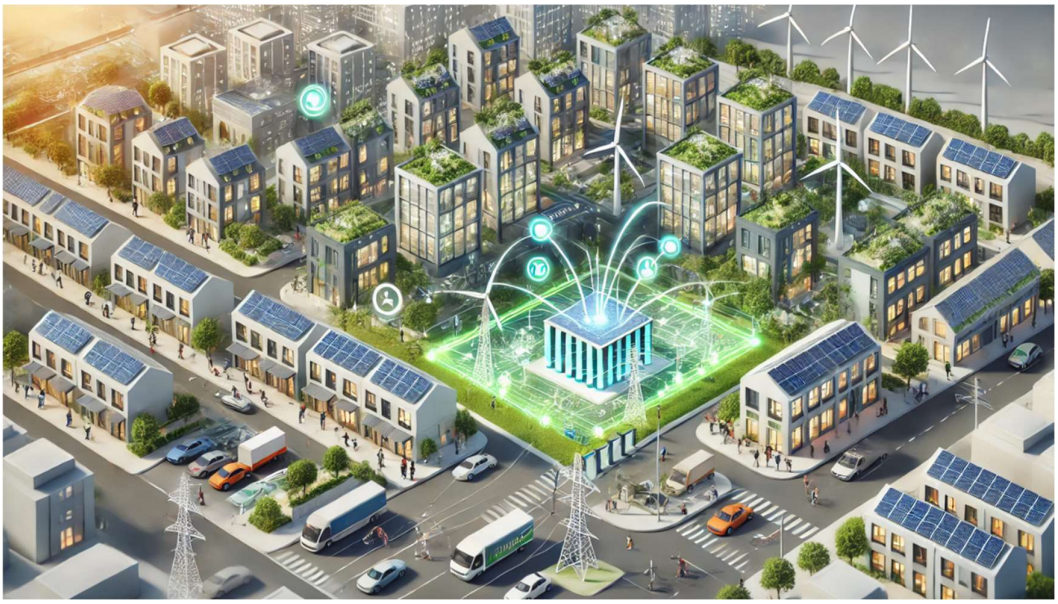
2. 2. Research focus 2: Local energy transition and positive energy districts (PEDs)

Positive Energy Districts (PEDs) are urban areas or groups of connected buildings designed to produce more renewable energy than they consume, resulting in net-zero greenhouse gas emissions. They address local production of renewable energy in combination with enhanced energy efficiency, often in combination with energy flexibility. PEDs represent a holistic approach to urban planning that aligns with climate action goals, fostering more sustainable, resilient, and liveable cities.

Research topics include:

- Energy system solution for local resilience of the power grid, including storage
- Participatory governance of PEDs through decentralised energy communities: neighbourhood energy solutions, self-sufficient (e.g., expertise in Metropolia's Innovation Hub Creative & Smart City, research programme Design for Regenerative Cities)
- Involvement of communities within energy transition
- Towards intradisciplinary research, designing participatory processes for engaging citizens and other stakeholder in sustainable energy transitions (e. g., expertise in Metropolia's Helsinki XR Centre)
- Cities Management platforms, subsystems integration and urban analytics

A joint research project on positive energy districts has started Jan 2025, financed by the EU Partnership Driving Urban Transition, with several U!REKA partners. This project will secure the research cooperation on PEDs within U!REKA for the coming period.



Positive energy district. Source ChatGPT

2. 3. Research focus 3: Sustainable commercial areas and business /industrial parks

When it comes to zero emissions, think of energy saving, sustainable energy sources for buildings, energy flexibility by means of, for example, energy hubs, and sustainable transport to/from business parks. Zero waste can involve technological, social and economic innovations to reduce residual flows and accelerate the transition to a circular economy. Examples are closed cycles, waste separation and modular commercial buildings. Within the zero impact of climate extremes focus, we are talking about heat, water and drought resilience

and biodiversity conservation in these areas. These complex challenges require an integrated approach with input from different disciplines.

Making business parks and companies more sustainable is lagging. This is because companies and stakeholders with different interests are involved. In addition, these are often investments that can only be made by several companies together, such as the construction of a joint charging station for electric trucks. Collaboration between companies and with other stakeholders is crucial to get sustainability off the ground in business parks. The research will require the cooperation of all three U!REKA CoEs.

AUAS has carried out a broad consultation among societal stakeholders (2024), including local and regional administrations, energy companies, knowledge institutes, large and smaller companies. The objective was to gather the main challenges the sustainability transformation of industrial parks face. While the list below refers to the Amsterdam region, we expect that these will also largely apply to the other cities and regions of the U!REKA. This will be validated as a next step.

Table 4. Challenges on sustainable business parks

Theme	**Challenge**
Climate neutral	How can the flexibility in local energy demand be used to address congestion?
	How can de production process of companies be improved to save energy?
Zero waste (circularity)	How can we reduce waste flows on industrial parks? How can we organise and establish joint governance for circularity?
Resilience for climate change	How can we store water on site (droughts and floods)?
	What is the best design strategy to make the critical infrastructure resilient?
	What are the options for greening to abate heat stress?
Governance	How can we make innovations and pilots possible?
	What type of governance would make joint responsibility possible?
	How can we make sharing of data between parties possible?
	How can we translate objectives and goals into workable guidelines and principles?
	How can we achieve synergy between living/housing and industrial activity on one site?
	How do we guide vital regional and local hubs towards resilience and self-sufficiency?

The consultation also asked the stakeholders what knowledge and skills future professional would need to work in this area. They stressed skills in integrated cross-domain thinking, reporting skills and data-analysis.

A joint research project on this topic may start in Q3 2025, financed by AUAS. This project will secure the research cooperation on this topic within U!REKA for the coming period.

Commercial/industrial park. Source ChatGPT.

2. 4. Research focus 4: Sustainable urban mobility and logistics

Urban personal transport, which includes the movement of people within cities using various modes of transportation, has a significant impact on climate change, other environmental areas, as well as other aspects of sustainable urban living. Major solutions include modal shift (public transport and active travel), shift to less polluting fuels (e-mobility) and urban planning, reducing the need for transport. Mobility has been identified as the top priority for the productive, smart and connected city in the forward-looking survey conducted by the European Urban Initiative.

City logistics, which involves the transportation and distribution of goods within urban areas, plays a significant role in climate change due to its impact on greenhouse gas (GHG) emissions. Also, the transportation sector, including urban freight transport, is responsible for a significant portion of air pollutants. To mitigate the impact of city logistics on climate change, various measures are being implemented. These include the adoption of electric and hydrogen vehicles, the use of drones for deliveries, and the optimisation of delivery routes.

Topics could include both the engineering/technology development angle, as well as the development of new policies and processes for optimising, monitoring and/or controlling vehicle utilisation and emissions:

- E-mobility charging infrastructure
- Transport hubs in city`
- Urban transport policies
- Smart and sustainable mobility services
- Intelligent Transportation System

- (white label) Parcel locker as a mean of reducing CO2, Zero Emission Transport, Last Mile problems and solutions
- Mobility and logistics hubs, e-mobility, mobility as a service
- New revenue models, smart logistics concepts, innovative technology, city hubs and government policy.
- Circular and sustainable supply chains
- Use of (also light electric) zero-emission vehicles, catering supply, waste disposal, construction logistics, service logistics and public procurement.
- Sniffer vehicles and research capabilities on air pollution (e. g. , expertise in Metropolia Innovation Hub Clean and Sustainable Solutions)
- Construction site logistics integrated with advanced construction management systems (e. g., lean construction or takt-time scheduling); utilisation of automatic identification and tracking of products, materials, equipment, and other resources

2. 5. Research focus 5: Economic innovation and sustainable financing

Economic innovation involves creating new financial mechanisms and business models to support sustainable urban development. These initiatives not only reduce carbon emissions but also create economic opportunities through green jobs and sustainable industries. Effective corporate governance is essential for ensuring that businesses align with climate goals. This includes adopting transparent decision-making processes and integrating environmental, social, and governance (ESG) criteria into corporate strategies. New business models are being developed to address the unique challenges of climate-neutral cities. These models often focus on circular economy principles, where resources are reused and recycled to minimise waste. Innovations in this area include decentralised energy systems, smart grids, and sustainable urban mobility solutions. Cities are also exploring new partnership models that involve various

stakeholders, including local governments, businesses, and communities, to drive systemic change.

Green financing and banking play a crucial role in addressing climate change by directing capital towards sustainable projects and influencing corporate and public sector behaviour. This includes financing clean energy projects with preferential conditions, influencing corporate behaviour, and green finance. Research in this area is focused on both the providers of finance (funds and banks) and the beneficiaries (including public sector).

Research topics include:

- Assessment of business cases of climate mitigation and adaptation policies and measures from business, client and societal point of view.
- Developing new business models in case the existing business models are not feasible, ensuring financial sustainability of climate action projects (operational need for funding and finance, identified in the future-looking survey of European Urban Initiative)
- Involvement and engagement of private sector investors and capital into development projects, mobilising private investment (operational need for funding and finance, identified in the future-looking survey of European Urban Initiative)
- Involving social economy within the processes
- Green financing and green banking
- Innovative funding for new business models in the built environment (NEB Facility thematic area)
- Corporate governance and CSR
- Enhanced and sustainable public procurement, policies and regulatory environment
- The role of public and private finance towards climate neutral and resilient cities, combining funding sources (selected as top 1 operational need for funding and finance by most of the respondents to the forward-looking survey of the European Urban Initiative), highlighted by focus group on “funding, financing and partnerships” of NetZeroCities’ report on city needs, drivers and barriers
- Governance at financial institutes towards sustainability
- Innovative funding for new business models in the built environment, moving away from a project-based approach and scaling up of piloted solutions

2. 6. Research focus 6: Urban resilience to climate change

Research on urban climate change adaptation and resilience focuses on how cities can prepare for, respond to, and recover from the impacts of climate change, including: 1) integrated, climate risk-informed development approaches. This involves addressing not just climate change but also poverty reduction, energy efficiency, low-carbon transportation, waste management, and public health; 2) How Urban Social-Ecological-Technological Systems (SETS) respond

to climate pressures [7]. This includes changes in land and resource management, social organisation, infrastructure, and design; 3) Urban climate change resilience also involves disaster risk reduction. This includes actions to mitigate the impacts of climate-related disasters and enhance the ability of urban areas to recover from such events [8]. Cities can adopt nature-based solutions to address both biodiversity loss and climate change. This includes creating green roofs, urban wetlands, and wildlife corridors that support biodiversity while also providing climate resilience. Integrating biodiversity and climate considerations into urban planning and policy can lead to more sustainable and resilient cities. This involves collaboration between policymakers, urban planners, and the community. By fostering biodiversity and incorporating nature into urban environments, cities can enhance their resilience to climate change, improve the quality of life for their residents, and contribute to global sustainability efforts. This research domain will require the involvement of the other U!REKA CoEs as well.

The research topics include:

- Heat stress mitigation
- Water management
- Weather forecast and events
- Biodiversity and nature-based solutions, urban farming (e. g. , expertise in Metropolia Innovation Hub Clean and Sustainable Solutions) [8, 9]
- Greening our universities' campuses [10]

In this area, a research proposal has been submitted for funding to the Driving Urban Transition programme with several U!REKA partners. The proposal addresses small-scale, circular and resilient nature-based solutions in water, waste and biodiversity.

Climate resilient public spaces. Source ChatGPT

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